

# Conclusions

In regions of the United States subject to tornadoes, the identification of best available refuge areas within schools and other public buildings is essential for the safety of building occupants. Shelters specifically designed and constructed to resist wind-induced forces and the impact of windborne debris provide the best protection. However, findings from investigations of past tornadoes show that many buildings contain rooms or areas that may afford some degree of protection from all but the most extreme tornadoes (i.e., tornadoes ranked F4 or F5 on the Fujita Tornado Damage Scale—see Chapter 1). In buildings not designed and constructed to serve as shelters, the goal should be to select the **best available refuge areas**—the areas that will provide the greatest degree of protection.

A building administrator, working with a qualified architect or structural engineer, can select the **best available refuge areas** within a building. As discussed in Chapter 4, the selection must account for the required amount of shelter space, the layout and structure of the building, and potential missiles at and near the building site. In general, the **best available refuge areas** will meet the following criteria:

**Interior rooms.** Rooms that do not depend on the exterior walls of the building are less likely to be penetrated by windborne debris.

**Location below ground or at ground level.** Upper floors are more vulnerable to wind damage.

## Chapter 5: Conclusions

**A minimal amount of glass area.** Typical windows and glass doors are extremely vulnerable to high wind pressures and the impact of windborne debris.

**Reinforced concrete or reinforced masonry walls.** Reinforced walls are much more resistant to wind pressures and debris impact, but can fail if the roof deck is blown away.

**Strong connections between walls and roof and walls and foundation.** Walls and roofs will be better able to resist wind forces when they are securely tied together and anchored to the building foundation.

**Short roof spans.** Roofs with spans of less than 25 feet are less likely to be lifted up and torn off by high winds.

As illustrated in the case studies and selection procedure presented in this booklet, long central corridors often qualify as the **best available refuge areas** in a school building. In addition to having desirable structural characteristics (e.g., short roof spans, minimal glass area, and interior locations), corridors usually are long enough to provide the required amount of refuge area space and can be quickly reached by building occupants. Other potential refuge areas include small interior storage rooms, restrooms, and offices.

Building administrators should also consider increasing the resistance of existing rooms or areas within a building whenever repairs or reconstruction are necessary. In high-risk areas, it may be prudent to perform remedial work (such as that noted on page 54) without waiting for other repairs or reconstruction to become necessary. As discussed in Chapter 3, the modifications made to the Kelly Elementary School during reconstruction after tornado damage are an excellent example of what can be done to improve the wind resistance of a school and provide shelter areas.

In conclusion, it is particularly important for building administrators and building occupants to be aware that the best available refuge areas do **not** ensure the safety or survival of their occupants. They are simply the areas of a building in which survival is most likely. To provide a high reliability of safety, a shelter area must be intentionally designed and constructed as a shelter. Refer to FEMA publication 361, *Design and Construction Guidance for Community Shelters*, for shelter performance criteria, sample construction plans, and other detailed information.